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BRIEFS

Two-photon cascade in InAs quantum dots

Pairs of correlated single photons have been obtained from the emission cascade of an isolated InAs quantum dot. The cross correlation function of the two photons in a pair exhibits the co-existence of asymmetric bunching and antibunching features, which is the signature for their sequential emission with a definite order. This allows the use of semiconductor quantum dots as triggered sources of photon pairs with strong quantum correlations for quantum information applications. Collaboration and further research or development support is being sought

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Solid state photon source on diamond

A stable solid-state room temperature source for single photons is reported, based on the fluorescence of a single nitrogen-vacancy (NV) colour canter in a diamond nanocrystal. Antibunching has been observed in the fluorescence light under pulsed excitation. The source delivers 105 s-1 single-photon pulses at an excitation repetition rate of 5MHz. The number of two-photon pulses is reduced by a factor of 14 compared to the strongly attenuated coherent sources. Collaboration or further R&D support, joint ventures or information exchange wanted.

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Strained silicon polymer transistors aired to compound's single hand applause.

Gene Fitzgerald of MIT (and Amberwave Inc) discussed the history of strained silicon. He explained that there are only four big IC products that are surfing the advances of Moore's Law: FPGA, DSP, microprocessors, and memory. Making existing sized designs with faster transistors will have more impact than stuffing more transistors on the same chip size. Another problem is in layout of large ICs with the interconnections between transistors. Fitzgerald looks at future microsystems as wanting to combine three vastly different functions: the digital, fast analog, and the interface with E&M waves. The last two functions are the bottle neck for microsystems, since they are made of compound semiconductors which have not been obeying the same manufacturing history curves as silicon. He finds that by adding enough layers and enough Ge to some of these layers that all functions can be made on the same chip using existing manufacturing equipment. One such layering system has strained silicon on top, next a Si (80%) Ge(20%), graded SiGe layer to reduce lattice mismatch and a bottom Si substrate. Using variations of these strained layers gives electron mobility of 80% with another Ge rich layer which eventually increases hole mobility by 800%. The low temperature formation of some of these layers is currently being addressed. If one of the layers has Ge >70%, one could add opto sources to the chip. One could also lower voltages even further with increased Ge. In summary, he considered that there is room for 1000% performance improvements by making 'designer' strained wafers for existing foundries.

Dr. Henning Sirringhaus of Plastic Logic Ltd presented the era of polymer transistors. Most of the audience was brought up fighting with inorganic crystalline semiconductors so this presentation made the first one seem almost possible. Sirringhaus basic premise was printing is a cheap, efficient, well known technology. If polymer materials can be refined so transistors of reasonable characteristics can be 'printed' at the same dpi as the '*National Geographic*', many applications will be performed by polymers rather than silicon. Work to date has been on 'pMOS' with special surface adhesive pattern treatments to allow short channels to be easily printed. Best mobility has been achieved by vacuum deposition of pentacene. Mobility is $5cm^2$/v.s. If this seems low, he pointed out that in the last decade mobility in polymers has improved 4 orders of magnitude with no obvious future brick wall.

Everyone expected another presentation on the leading edge of compound semiconductors. But while several speakers had been lined up, their companies declined support. Since compound semiconductors have been the future for most of the audience engineers' careers, this may mean the beginning of the end of the compound industry (apart from niches like traffic lights). Yet again the silicon juggernaut grinds down the competition.

Source:http://www.ewh.ieee.org/soc/cpmt/newsletter/200306/planery.html

Electromagnetic screening

A Bulgarian company has invented a new multi-layer metal coating deposited by chemical and electrochemical methods onto the surface acrylonitrile butadiene styrene - copolymer parts of the electronic device (e.g. telephone set). The individual layers can be either from a single metal (e.g. copper, nickel, iron), or alloys and composite materials as a polymer matrix containing highly dispersed fine-grained metal powder. The electromagnetic screening of electronic devices against unauthorised access is in conformity with US military standard-MIL-STD-461E/1999, applicable mainly in the telecoms and military industries. It is also used to protect equipment against extrinsic electromagnetic interference.The company is interested in licensing, joint venture and manufacturing agreement.

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BASF invests

BASF is investing in Micro Emissive Displays Ltd of Edinburgh as is lead investor Scottish Equity Partners and 3i, raising a total of $7.5m. MED has developed microdisplay technology based on light-emitting polymers now ready for market. Compared with liquid crystal displays, the new materials are characterised by significantly lower power consumption and production costs. The market expects to reach $2.2bn by 2006.

Adaptive computing's impact?

"We're coming upon a sea change in the world of semiconductors," says Nick Tredennick, former designer of the Motorola 68000 microprocessor, which powered the Apple Mac in the 1980s and early 90s. "There are compelling advantages to reconfigurable chips in terms of performance and power consumption." The momentum for adaptive computing is a result of advances in special high-speed memory chips called static ram, or S-RAM chips that make it possible to imitate the entire hardware circuits of a processor on a single chip. In adaptive computing, chip wiring would be reconfigured on the fly by software altering the circuitry's information pathways. Reconfigurable chips may offer speed, cost and energy-saving advantages, and allow for quicker product design cycles. And the ability to combine the functions of many chips into one would be particularly desirable in making smaller, lighter and more energy-efficient portable computing and communications devices. Cellphones that could work worldwide; portable computers that use suitable radio frequency and wirelessly, automatically connect to the Internet, or consumer electronics gadgets able to adjust to each new technical standard in digital sights and sounds, offer enormous attractions with upgrades as easy as downloading the latest circuit design from the Internet. The fixed-circuit approach needs templates, or masks at $1m for each new circuit, making it difficult for product designers to quickly adapt to changing markets and technology formats. But for an adaptive circuit, that investment is not unreasonable. Reconfigurable chip design has several dozen start-ups (eg QuickSilver, and GateChange Technologies), as well interesting the giants. Intel, IBM, Infineon, Motorola and Texas, have all moved into both acquisition and spin-off. Infineon acquired Morphics Technology (reconfigurable circuits for wireless digital telephone networks). Royal Philips Electronics acquired Systemonic, (reconfigurable chips for wireless data applications). Motorola invested in Morpho Technologies (reconfigurable circuits for wireless, imaging and multimedia applications). HP research laboratories has spun off two adaptive companies, Synfora (Program-In Chip-Out PICO) and Elixent (Reconfigurable Algorithm Processing RAP). Reconfigur-able looks as if its coming to stay.

Electronic progress in materials science

Materials such as polymers, superconducting ceramics, and diamond films are likely to shape the electronics industry in the coming decade. Processing technologies for these improved materials will also gain importance.

"Advanced materials are synthesised at nano levels, creating the possibility of achieving several new structures and properties, which will enable an endless number of electronic applications," states Technical Insights analyst, Sathyaraj Radhakrishnan.

Nanostructures based on inorganic and organic semiconductors, coupled with complex materials such as polymers will form the building blocks for many future devices and systems says Radhakrishnan. "Researchers will need capital-intensive, large-scale instrumentation to characterise, synthesise, and process new materials from their smallest constituents and at all scales of assembly.

"Electronics sector advances will depend on the ability to assess life cycle costs, which include materials costs, and overcome stringent management policies and limited investment funding. Performance optimisation, miniaturisation, and integration of different classes of materials into multifunctional components are also becoming essential, as advanced electronic materials are finding a prominent place in many applications. Researchers are working on an array of new technologies including elaboration and characterisation of very thin dielectrics for gate control, enabling reliance on fewer electron memories, lithographic techniques, and optical interconnects. Many research frontiers such as synthesis of semiconducting organic materials, optical conductivity of doped conjugated polymers, holographic data storage, plastic displays, and ferro electric ceramics are also evolving.

"Multidisciplinary international collaboration is essential to make progress as challenges persist in the form of a choice of substrates, control of dopants, growth techniques to identify native defects, and quantum fluctuations," concludes Radhakrishnan.

Electronics and Semiconductors Industry Impact Research Service: *Developments and Opportunities in Advanced Electronic Materials Report*
Http://www.Technical-Insights.frost.com

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Organic molecule shows blue

A molecule commonly used in LED fabrication shows promise for making an organic diode laser that emits in the blue. María Díaz García and colleagues at the University of Alicante observed gain from the molecule, which is called TPD, when they pumped it with a 355 nm frequency-tripled Nd:YAG laser. TPD is used as a hole-transporting layer in LEDs, and is already widely available. The film that showed gain was made by a simple spin-coating technique, which would be far cheaper than the epitaxial deposition techniques used to make inorganic diode lasers.

Green gold

A new way to make gold form inside the cells of a micro-organism has been developed by the National Chemical Laboratory and the Armed Forces Medical College, in Pune, India.The technology could also be used in developing nanomaterials and nanoelectronics.

The research group took a micro-organism called Rhodococcus from a fig tree, and exposed it to a liquid containing gold ions. The micro-organism caused the gold ions to gain electrons, thereby forming gold nanoparticles within the micro-organism's cells. These are more concentrated and uniform in size than particles biosynthesised by previous methods using fungus.

The group will be looking into making the nanoparticles on a large scale, which could be attained by genetically modifying actinomycetes to produce more of the enzymes which cause the gold to form.

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Protein traps

Researchers from the University of Tokyo in Japan have adapted a tubular bacterial protein for technological applications by coaxing it to combine with individual luminescent semiconductor nanoparticles. In bacteria, this chaperonin protein takes in and re-folds denatured proteins in order to return them to their original useful shapes. Cadmium sulfite nanoparticles emit light as long as they are isolated from each other; encasing the nanoparticles in the protein keeps the particles apart.

The biological fuel molecule ATP releases the nanoparticles from the protein tubes, freeing the particles to clump together, which quenches the light. The protein-nanoparticle combination could be used to detect ATP, according to the researchers who are working on using the combination to detect specific ATP concentrations.

They are also working on coaxing the protein to capture and release organic molecules. This would make the proteins good candidates for drug carriers. The protein-nanoparticle combination could be used in practical applications in three to five years, according to the researchers

Display consolidates

Cambridge Display Technology (CDT), the UK developer of light-emitting polymers (LEPs), is consolidating its operations. CDT is to close the plant it owns in Oxford, UK and move the scientists working there to its Cambridge headquarters. The firm is also relocating all of its process development activities to its Godmanchester facility, which is located just outside Cambridge.

Flexible sensing circuit

By combining nano and micro technologies, researchers have fabricated three-dimensional (3-D) flexible circuits, where clusters of nanowires form the vertical via connections.

The nanowires, embedded in foils of polyimide plastic, are interconnected with two lithographically structured metallic surface layers. As the wires are defined by ion track technology they are stochastically distributed with a uniform density in macro-scale. They are highly parallel in well-defined directions in the foil. The key structural element is a junction, where overlapping lateral interconnection lines on the surface intersect with clusters of perpendicular or tilted wires.

The demonstrated circuit structure is in essence a magnetic field sensor, since the wires are made of nickel, a magnetoresistive material The essential fabrication process comprises: ion track generation by means of heavy ion irradiation, selective ion track etching, electrodeposition of nanowires, and double-sided photolithography.
The polyimide, for use in flexible printed circuit boards, is for the first time evaluated as a carrier for nanowires.

Chemical properties and stable temperature makes the polyimide an appropriate material for implementation of electronic circuitry by ion- and photolithography.

Interconnected nanowire clusters in polyimide for flexible circuits & magnetic sensing applications. M. Lindeberg & K. Hjort *Sensors & Actuators* A 2003, 105(2): 150–161

Pulsed growth

Beryllium nitride thin films, candidates for optoelectronic applications, have been grown by pulsed laser deposition on silicon substrates. The films were prepared by ablating a beryllium foil in an N2 environment at several pressures and substrate temperatures. Real-time ellipsometric monitoring for the period of deposition was carried out in the 1.625 to 4.405 eV photon-energy range.
The films were characterised in situ by electron spectroscopies and ex situ by AFM and SEM. A model for the growth of beryllium nitride was applied to reproduce the optical measurement and concurrently, the refractive index from the visible to the near ultraviolet spectral region was calculated. The estimated optical bandgap 4.0-4.2eV correlates closely with previously published theoretical results.

G. Soto, R. Machorro, J.A. Díaz, et al. *Thin Solid Films 2003,* 434(1-2): 7–13

Dynamic Electroluminescence Imaging

The Canadian National Research Council's Institute for Microstructural Sciences (NRC-IMS) and MuAnalysis have begun a research agreement to jointly develop methods to detect semiconductor anomalies using a new technique known as Dynamic Electroluminescence Imaging (DEI). The aim is to develop commercial, practical applications of this technology to pinpoint minute errors in today's complex semiconductor devices. DEI is a technique in semiconductor analysis that allows scientists to capture and analyse images from microscopic electronic devices while these are operating. NRC-IMS has recently developed an instrument to perform DEI that is currently the only one of its kind in Canada. The instrument has been installed at MuAnalysis headquarters in Ottawa.

Single-photon quantum cryptography

The first full implementation of a quantum cryptography protocol, using a stream of single photon pulses generated by a stable and efficient source operating at room temperature has been carried out. The single photon pulses are emitted on demand by a single nitrogen-vacancy (NV) colour centre in a diamond nanocrystal (deliverable 1.2). The quantum bit error rate is less that 4.6 % and the secure bit rate is 5800bits/s. The secret key has been distributed over 50m in free space. Using the published criteria that warrant absolute secrecy of the key against any type of individual attacks, it has been shown that the overall performances of the system reaches a domain where single photons have a measurable advantage over an equivalent system based on attenuated light pulses. Collaboration is required for further R&D or venture capital/spin-off funding.

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Harmless water

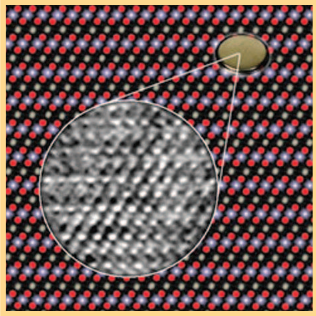
Photolithography resists are surprisingly unaffected by contact with water. Early pattern imaging at IBM on wafers immersed in water “worked much better than we thought,” said Bill Hinsberg, a research staff member. Hinsberg said IBM immersed wafers coated with normal chemically-amplified photoresist in water for up to a minute. Wafers were removed, dried, and exposed with a normal 193nm scanner. The resulting patterns show little degradation compared with resists not exposed to water. The resists tested did absorb some water, but this does not seem to have a major impact on performance. In the late ‘90s, IBM research showed in tests that immersion lithography could provide dramatic improvements in resolution. Using tools and resists for 0.25μ lithography, the IBM team showed that immersion could produce 45μ lines & spaces. Progress at MIT's Lincoln Lab, the Rochester Institute of Technology and other research centers have prompted speculation that 193nm lithography with immersion could be used for the 32μ node by the end of the decade.

Cadence buys Verplex

Cadence Design Systems Inc will acquire Verplex Systems Inc, whose formal verification software will be integrated with Cadence Incisive and Cadence Encounter platforms for IC design to enable efficient and independent verification for the industry's route to big, fast chips. Cadence also will continue to support Verplex products in alternative flows. “A roadmap for incorporation of Verplex's products is currently under development,” says Cadence GM, Penny Herscher.

OÅM catches lithium atom

Researchers have used a One Angstrom transmission electron microscope to image lithium atoms. Only atoms of hydrogen and helium are smaller and lighter than those of lithium, which under ordinary conditions is not a gas but a soft, white metal. Yang Shao-Horn of the Department of Mechanical Engineering at the MIT and Michael O'Keefe of Berkeley Lab's Materials Sciences division used the OÅM to simultaneously resolve columns of lithium, cobalt, and oxygen atoms in the compound lithium cobalt oxide ($LiCoO_2$). The structure of $LiCoO_2$ is known theoretically and has been confirmed with x-ray diffraction and neutron powder diffraction: layers of lithium atoms lie between slabs of cobalt and oxygen, which are arranged in octahedrons. Experimental imaging of the lithium ions and vacancies proved difficult in this study,” says Shao-Horn. “Nevertheless, the atomic resolution of lithium atoms is a novel and significant achievement, with implications for better understanding not only of lithium ion battery materials but of many other electroceramic materials as well.”



$LiCoO_2$: A simulation program shows how the arrangement of lithium ions (tan) among cobalt (blue) and oxygen (red) atoms in lithium cobalt oxide ought to appear. The closely matching experimental image obtained with the OÅM is inset in black and white.

Frequency doubling for near UV range

Although many materials are capable of generating laser light, few operate at the shorter wavelengths. Scientists from the Fraunhofer Institute have a laser that produces wavelengths of down to 370μ, near UV range, achieved by a frequency-doubling technique. Andreas Hofmann leads the IPM’s laser imaging research group, which has managed to achieve a selective effect by applying electric fields to crystals of lithium niobate. Using an IPM-patented drive system, they have been able to achieve several milliwatts for the first time. Frequency doubling offers the advantage of allowing commercial laser diodes to be used as the pumping device. These emit in the visible to near IR region, at wavelengths between 740μ and 1,100μ. At an output power of 100 milliwatts, the beams are of sufficiently high quality to enable the short-wavelength main laser to be used in imaging, analysis and diagnosis instruments. The beam can be directed and modulated by deliberately modifying the molecular structure of the lithium niobate crystal. Metal electrodes are placed on the two surfaces of the crystal slice. When an electric field is applied, the crystal axis between the two electrodes switches permanently to the opposite sense. Domain inversion produces lasing areas of a defined geometry within the crystal and is a prerequisite to volume processing of such crystal wafers.

3D metamaterials

Joint work on lead selenide (a semiconductor with applications in infrared detectors and thermal imaging and that can be tuned to be more sensitive to specific infrared wavelengths) and magnetic iron oxide (best known for its use in the coatings for certain magnetic recording media) has allowed IBM to announce new 3D designer metamaterials.

According to the Columbia and New Orleans University scientists who designed the new metamaterials, 2D patterns have previously been created from gold nanoparticles of different sizes and mixtures of gold and silver.
Extending this to 3D with more diverse types of materials gives the ability to bring more materials together than previously recognised. The combination of these nanoparticles may have novel magneto-optical properties as well as properties key to the realisation of quantum computing.

Harris R&D

Harris Corp in communications technology has approved a R&D agreement with the University of Florida's College of Engineering, facilitating collaboration between Harris and the university in a variety of engineering fields. Kwame Boakye, Harris VP of technology says “We have synergy in a number of research areas, including advanced communications, nanotechnology, mechanical systems, power systems, database and information processing.”